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HUMIDITY AND THUNDERSTORM FORECASTING IN
COMPUTER WORDED FORECASTS

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1. INTRODUCTION

Ever since its inception, the operational program that produces computer worded forecasts (CWF's) for stations and zones (Glahn, 1978; Heffernan and Glahn, 1979; National Weather Service, 1983b and 1983c) has been undergoing improvement. Among the more important advancements have been the addition of a 1200 GMT cycle version of the program, inclusion of combining of forecast periods with similar worded forecasts, inclusion of warnings, improved formatting of the CWF's including optional placement of the PoP statement, improved precipitation type forecasts, and addition of a version of the program that forecasters can interact with on AFOS. A discussion of some of these is available in Bermowitz et al. (1980) and Bermowitz and Miller (1984).

Recently, two additional changes have been implemented that should result in improved CWF's. The first is the addition of humidity to the descriptor used in the temperature forecast so that phrases such as "warm and humid" and "hot and humid" can occur. The second involves a changeover to the thunderstorm probabilities (Reap and Foster, 1979) that appear on the FPC message (National Weather Service, 1983a) along with appropriate threshold probabilities to trigger the phrase "thunderstorms." Included in the second change is the addition of conditional probabilities of severe thunderstorms and associated threshold probabilities (Reap and Foster, 1979) to activate the phrase "some possibly severe." These two improvements are the subject of this paper.

2. HUMIDITY

During the warm season, it is not uncommon, especially in the middle and northern latitudes of the conterminous U.S., to modify the temperature descriptor in a public weather forecast with an expression of relative discomfort because of high humidity. Thus, a phrase such as "and humid" could be added to "very warm," "hot," etc. when conditions warrant. The problem, of course, is to define a threshold condition for some index above which expressions of discomfort would be used. Unfortunately, this threshold condition tends to vary from person to person depending upon such things as age and overall health. It also can vary season to season. For example, an unusually warm day during spring may feel uncomfortable, but that same day after a heat spell during summer may feel relatively pleasant.

First, however, it is necessary to find an index of discomfort that would be universally understood and easily interpreted by forecasters using the CWF so that they can select a suitable threshold condition. Furthermore, the index has to be available or easily calculated from the digital forecasts that form the basis for the generation of the CWF phrases. A number of heat stress indices are available, for example, apparent temperature, temperature-humidity index, (THI) and humidity. For a concise discussion of these, see Quayle and Doehring (1981). Another measure of discomfort when used in conjunction with temperature and, therefore, a potential index, is the dew point temperature.

In general, apparent temperature, THI, and humidity are not that well known. On the other hand, forecasters are familiar with the dew point as an indicator of sultriness, simply because they regularly see it in the hourly observations. For this reason and the fact that it is readily available in the matrix of digital forecasts, dew point was selected as the discomfort index. Although there would undoubtedly be some variation in the choice of a threshold dew point among forecasters at a particular WSFO, it's probable that most forecasters can rather easily select an appropriate value for their locale that will work reasonably well in the CWF.

Humidity in the form of the phrases "humid" and "and humid" will be added to the temperature phrase in a given forecast period only when the phrase is either "warm," "very warm," "hot," "very hot," "continued hot," or "continued very hot" and the dew point at the middle of that period is equal to or greater than the threshold value. The threshold value has been set at 65°F for all WSFO's and will remain there until we receive a request to change it. It should be pointed out that the use of "humid" is entirely optional. If a WSFO does not want to exercise this option, the threshold value can be set sufficiently high so that it will never be exceeded. The fact is that "humid" probably will not occur that often even if a reasonable threshold value is used. The reason is that the temperature phrases that permit use of "humid" occur when the predicted temperature is more than 6 degrees above normal, there has been little change in temperature from the previous day, and the selected amount of detail in the temperature phrase, or phrase complexity, is high (see Glahn, 1978 and National Weather Service, 1983b for additional details). So, for example, even if the dew point exceeded the threshold and a forecast max temperature of 92°F was little changed from the previous day's max, but only within 3 degrees of normal, then a temperature phrase that would permit "humid" would not appear.

It is possible to have a situation where "humid" would be used in one period when the dew point slightly exceeds threshold and would not be used in another period when the dew point is slightly below threshold. To avoid this situation, the threshold dew point is made somewhat flexible. For example, if one daytime period's dew point exceeds the threshold and the other daytime period's dew point does not, the difference in dew points between these two periods is computed. If this difference is 3 degrees or less, then "humid" can also be used in that period in which the dew point is less than threshold.

Also, if a nighttime period's dew point is less than the threshold, but the daytime periods on both sides of this nighttime period use "humid," then the nighttime period will also use humid--provided the dew point for the nighttime period is greater than or equal to the threshold value minus 4 degrees. This is an attempt to account for the normal diurnal variation of dew point. Furthermore, for the first period of the 1200 GMT cycle (a nighttime period with no daytime period preceding it), "humid" can be used even if the dew point is less than the threshold provided periods two and three have "humid," the dew point difference between periods one and three is less than or equal to 3 degrees, and the first period dew point is greater than or equal to the threshold value minus 4 degrees.

Fig. 1 shows an example of the use of "humid," specifically the phrase "and humid" in the first and third forecast periods. In both of these periods, the dew point at mid-period is either the same as or exceeds the 65°F threshold. If one of the temperature phrases that allows "humid" to be used had appeared in the nighttime period, then this period also would have contained "humid" even though the mid-period dew point is less than threshold. In this case, both daytime periods use "humid" and the mid-period nighttime dew point (64°F) is greater than the threshold value minus 4 degrees (61°F).

3. THUNDERSTORMS

Thunderstorm probabilities are used to add the phrase "and thunderstorms" to "rain" or "showers," provided the 12-h probability is equal to or exceeds some threshold value. Until recently, the thunderstorm probabilities used in the CWF program were produced from MOS equations (Carter, 1975) derived specifically for the CWF; these are not the same probabilities that appear in the FPC message. When the CWF was originated, the FPC thunderstorm probabilities were not available for 12-h periods. This necessitated development of the additional thunderstorm equations for the CWF for three periods for the 0000 GMT cycle and four periods for the 1200 GMT cycle.

A changeover to the FPC thunderstorm probabilities is desirable for two reasons. First, improved FPC probability forecasts and threshold probabilities as a result of a more rigorous development (Reap and Foster, 1979) should result in better thunderstorm forecasts in the CWF. Second, forecasters are more familiar with the FPC probabilities and their interpretation than with the thunderstorm probabilities derived specifically for the CWF. This is especially relevant when the CWF is used as a local program in an interactive mode. Currently, the FPC probabilities and threshold values are available and are used in the CWF program for all 12-h periods, except for the fourth period on the 1200 GMT cycle where they are available for only the western United States grid (National Weather Service, 1983a). For this projection, the original thunderstorm probabilities derived for the CWF and single threshold value are still used over the entire United States.

Threshold values are available for each of the eastern and western United States grids and for the warm (Mar. 15-Sept. 30) and cool (Oct. 1-Mar. 14) seasons. They were selected on the basis of providing desirable verification scores--see Reap and Foster (1979) for details. Warm (cool) season values being used are 25 (16) and 22 (13) percent for the eastern and western United States grids, respectively. For the fourth period on the 1200 GMT cycle, where the original thunderstorm probabilities are still being used, the threshold probability is 10 percent for both seasons and grids. As is the case for humidity, threshold values can be changed by each WSFO and will be if requested.

Another change that has been recently introduced into the CWF thunderstorm forecasts is the addition of conditional probabilities of severe thunderstorms. This makes it possible for the phrase "some possibly severe" to be used after "thunderstorms" in the first and second periods. For this to occur, the conditional probability of severe thunderstorms must be equal to or exceed a threshold probability, the PoP must be equal to or exceed 25 percent (35 percent for those WSFO's that use "slight chance of" with a PoP of 30 percent), and the phrase "thunderstorm" must appear in the CWF.

As was the case for the thunderstorm probabilities, threshold values for severe thunderstorms are available for each of the eastern and western United States grids. However, thresholds for severe thunderstorms are available for three, not two, seasons: spring (Mar. 15-June 15), summer (June 16-Sept. 30), and cool (Oct. 1-Mar.14). Threshold probabilities were selected on the basis of providing desirable verification scores, but with a tendency toward higher values to prevent overforecasting of the event. Spring (summer) (cool) season values being used are 9 (7) (6) and 14 (12) (11) percent for the eastern and western grids, respectively. As before, each WSFO can have these values changed.

An example of the use of "thunderstorms" and "some possibly severe" is shown in Fig 2. For the first two forecast periods, the thunderstorm probabilities--denoted by TSTM--are at least as large as the threshold value (25) which results in the phrase "and thunderstorms" added to "showers." Furthermore, for the first period, the conditional probability of severe thunderstorms--denoted by SVR T(T)--is larger than the threshold value (7) so that "some possibly severe" appears after "thunderstorms."

4. SUMMARY

Some recent changes to the CWF have been discussed. Humidity has been added to the descriptor used in the worded forecast of temperature so that phrases such as "warm and humid" can now occur. Also, a changeover to thunderstorm probabilities that appear on the FPC message along with associated threshold probabilities should improve the worded forecasts of thunderstorms. Finally, addition of conditional probabilities of severe thunderstorms and associated threshold probabilities will enable a phrase such as "some possibly severe" to be appended to "thunderstorms."

5. ACKNOWLEDGMENT

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6. REFERENCES

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DES MOINES, IA

ELEMENT	UNITS	VALID TIME															
		12Z		18Z		00Z		06Z		12Z							
		(---TODAY---)		(--TONIGHT--)		(-TOMORROW-)		(-TMRW NIGHT-)									
TEMP M/M	DEG F			91				71				91				71	
TEMP	DEG F	73	72	81	87	90	88	80	77	74	73	80	85	89	88	80	
DEW PT	DEG F	63	63	65	65	65	65	65	64	63	64	67	69	69	69	68	
POP (12)	PERCENT					11				33				46			30
POP (6)	PERCENT			6		7		14		26		37		21			
POF (P)	PERCENT	0		0		0		0		0		1		1		2	2
POZR (P)	PERCENT	0		0		0		0		0		0		0		0	0
PREC TYP	CATEGORY	3		3		3		3		3		3		3		3	3
R SHR (L)	PERCENT			100				97				83					
DRZL (L)	PERCENT			0				0				0					
RAIN (L)	PERCENT			0				5				19					
TSTM	PERCENT			23				24				31					
SVR T (T)	PERCENT			2				1				3					
QPF	CATEGORY					1				1				1			
LOUDS	CATEGORY	2		2		2		2		2		2		2		2	2
JB VIS	CATEGORY	1		1		1		1		1		1		1			
WIND D/S	DEG MPH	1607		1711		1612		1509		1608		1815		1813		1710	1808
CIG	CATEGORY	6		6		6		6		6		6		6			
VIS	CATEGORY	6		6		6		6		6		6		6			
SNOW AMT	CATEGORY																

DATE OF FORECAST IS FRI JUN 20 1986

EARLY GUIDANCE

DES MOINES, IA

.TODAY...MOSTLY SUNNY, CONTINUED HOT AND HUMID, HIGH IN THE LOWER 90S. LIGHT SOUTH WINDS.

.TONIGHT...PARTLY CLOUDY WITH A CHANCE OF SHOWERS. LOW IN THE LOWER 70S. LIGHT SOUTH WINDS. CHANCE OF RAIN 30 PERCENT.

.SATURDAY...PARTLY CLOUDY, CONTINUED HOT AND HUMID WITH CHANCE OF SHOWERS AND THUNDERSTORMS. HIGH IN THE LOWER 90S. BREEZY IN THE AFTERNOON. CHANCE OF RAIN 50 PERCENT.

Figure 1. An example of the use of the phrase "humid" in the first and third forecast periods. An explanation of each element in the matrix of digital forecasts is available in National Weather Service (1983b).

NEW YORK, NY

ELEMENT	UNITS	VALID TIME																		
		12Z		18Z		00Z		06Z		12Z		18Z		00Z		06Z		12Z		
		(--TODAY--)				(--TONIGHT--)				(-TOMORROW-)				(-TMRW NIGHT-)						
TEMP M/M	DEG F	84				59				72				56						
TEMP	DEG F	72	75	79	82	79	75	69	64	60	61	66	71	72	68	63				
DEW PT	DEG F	60	62	62	61	59	56	54	52	49	48	47	47	45	43	43				
POP (12)	PERCENT					49				26				4						
POP (6)	PERCENT					32				30				21						
POF (P)	PERCENT	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3				
POZR (P)	PERCENT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
PREC TYP	CATEGORY	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3				
R SHR (L)	PERCENT					89				40				36						
DRZL (L)	PERCENT					0				24				22						
RAIN (L)	PERCENT					18				36				43						
TSTM	PERCENT					45				25				0						
SVR T (T)	PERCENT					8				3				0						
DPF	CATEGORY					1				1				1						
CLOUDS	CATEGORY	2	3	3	3	3	1	1	1	1	2	1	1	1	1	1	1	1	1	
DB VIS	CATEGORY	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
WIND D/S	DEG MPH	2511	2416	3114	3313	3417	3315	3017	3410	3308										
CIG	CATEGORY	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6				
VIS	CATEGORY	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6				
SNOW AMT	CATEGORY																			

DATE OF FORECAST IS TUE JUN 24 1986

EARLY GUIDANCE

NEW YORK, NY

.TODAY...MOSTLY CLOUDY WITH CHANCE OF SHOWERS AND THUNDERSTORMS, SOME POSSIBLY SEVERE. HIGH IN THE MID 80S. WEST WINDS 10 TO 15 MPH. CHANCE OF RAIN 50 PERCENT.
 .TONIGHT...MOSTLY CLOUDY WITH A CHANCE OF SHOWERS AND THUNDERSTORMS IN THE EARLY EVENING, CLEARING BY MIDNIGHT. LOW IN THE UPPER 50S. NORTHWEST WINDS 10 TO 20 MPH. CHANCE OF RAIN 30 PERCENT.
 .WEDNESDAY...SUNNY, BREEZY, AND COOLER, HIGH IN THE LOWER 70S.

Figure 2. An example of the use of the phrases "thunderstorms" and "some possibly severe."